II.—*Memoirs on Geographic Botany.* By Richard Brinsley Hinds, Surgeon, R.N., Fell. Roy. Coll. Surg.

In the ninth volume of the 'Annals of Natural History' I have dwelt with some detail on the agents which constitute climate, more particularly as they influence vegetation. It will there be seen that a great number of different climates are produced by the repeated changes in the relations which the constituents bear to each other, and every portion of the globe, of any extent, will produce a state of things influencing its climate, which perhaps it would not be possible to match exactly at any other place. Whether vegetation obeys minutely these movements in climate is yet to be determined, but it is not improbable that there is a very powerful connexion between the flora of any particular region and surrounding circumstances; as not only every continent has its own peculiar forms, but even different portions of a continent have an assemblage of forms which are repeated feebly elsewhere. Before, however, adverting to the varieties which vegetation presents, there are some other circumstances for our consideration.

The earliest mention of the vegetable kingdom is contained in the sacred writings; we are there informed that *the earth brought forth grass, and herb yielding seed after his kind, and the tree yielding fruit, whose seed was in itself, after his kind.* Further than this they do not acquaint us with any facts on the subject, excepting that we find that it occupied one of the earliest of the omnipotent labours, preceding in its existence all other organized beings. Our curiosity as to the early state of vegetation, its amount, or how the whole world has been covered with its members, remains still unsatisfied. These were left for the subsequent inquiries of man, and perhaps also for his happiness, since experience has taught us the pleasure to be derived from the exercise of our intellectual faculties and in the gradual accumulation of knowledge. Nor on the other hand can we perceive, though the information is scanty, that there is room for any of those restricted ideas which have been entertained by some as to the limited number of vegetable beings at first called into existence, or of the very confined region they were supposed to occupy. The world had been long peopled before we find any additional information, and this is contained in the writings of those philosophers whose names have descended to our times with many of their works.

At that period very limited ideas prevailed respecting the numerical amount of the flora of the world, which has since been discovered to be so vast. The imperfect knowledge of geography then prevailing, and the small amount of accumulated

information, must account to us for not above a thousand different species being recorded. The ancients at the same time were not remiss in availing themselves of the properties of plants in the healing art, or for domestic purposes. To some extent the amount of known plants is an index of the advancement of the science, and on examination this will be found to have proceeded most irregularly; indeed none worthy of attention was made till the time of Linnæus. Subsequently a rapid advance took place, gradually increasing to the present time, when the progress outstrips all precedent.

Whilst the first naturalists were recording such plants as their exertions brought before their notice, none appear to have hazarded an opinion on the total amount of the vegetation of the world, till Ray ventured to fix it at 18,000. Though this amount may seem small, it most probably appeared at the time it was first promulgated of a more astonishing magnitude than the great amount to be presently mentioned, as in our opinion likely to be an approximation to the total flora of the earth, will to us in the present day. In the following details the first column expresses the amount known to or noticed by each authority, and the second column the total number of species which were, at the time specified, considered as existing on the globe:—

			Known.	Supposed Total.
A.C.	300	Theophrastus, History of Plants .	500	
A.D.	70	Pliny, History of the World .	1000	
	1580	Dodonæus, Stirpium Historia .	1330	
	1623	Bauhin, Pinax	6000	
	1690	Ray		18,000
		Tournefort	6000	
	1753	Linnæus, Species Plantarum, 1st ed.	7300	
	1762	„ „ „ 2nd ed.	8800	
	1796	Gmelin, Systema Vegetabilium .	16,635	
	1806	Persoon, Enchiridium	27,000	
		Humboldt		44,000
	1814	Brown, Flinders' Voyage . . .	37,000	
	1820	DeCandolle, Théorie Elémentaire	50,000	100,000
	1824	„ Prodromus . . .	50,000	
	1827	Sprengel	37,000	
	1830	Balbi, Géographie		80,000
	1835	Lindley, Introduction to Botany .		86,000

Perhaps no botanist ever conducted his researches on any class of plants without discovering that their amount exceeded all his expectations. This was particularly the case with ourselves when attempting to estimate the number of species spread over the world. As a foundation for these speculations, I took the num-

ber of species described in the first four volumes of DeCandolle's 'Prodromus Regni Vegetabilis,' a work unequalled for the correctness and copiousness of its details. Exactly one hundred families are described, and they comprehend 20,100 species*. The publication of this work commenced in 1824, and for the period intervening to the present time I have allowed 5000 more, including those which have been since described, or which are known to or in the possession of botanists, and have not hitherto been published. After looking back at the rapid progress of botany during this century, I feel perfectly justified in making the most liberal calculations, feelings by no means decreased on inspecting those portions of the globe as yet unexplored, and which do occasionally contain districts supposed to be as fertile as any known countries elsewhere. There remains to be included in this work from 150 to 200 natural families, for which I allow double the above number, or 50,200. The cryptogamic plants are not yet included; the estimate of these amounts to 13,870, which I consider as about the quantity either known from descriptions or existing in herbaria. The great total obtained from these is then the amount of plants at the present time in the hands of botanists, either from description or as dried specimens.

My conclusion as to the entire amount of vegetation rests on the hypothesis that two-thirds are at present known; and should any objections be raised to this, as leaving a far too liberal number undiscovered, it may be observed, that even in our own well-explored island additions are frequently made to the native flora, and the same is continually occurring throughout Europe. But setting Europe aside, it will not be easy to discover any other country, the vegetable productions of which have been thoroughly explored. India certainly has not; in Africa and Australia much has to be done, and no portion of either of the Americas has been examined with anything approaching precision, excepting the United States, and even in these many discoveries may yet be made. A great part of foreign countries are only examined at particular seasons, and often during those less favourable to the vegetation. In the tropics the wet season is the period for the prevalence of sickness and fatal fevers, and then vegetation assumes all its rank luxuriance; many are the herbaceous plants which are only then to be met with, and the traveller is usually deterred from visiting them—if not his own fears, the repeated warnings of the inhabitants compel him in the end to desist. Nature has been as bountiful to some parts of Africa as any other country, vegetation is wonderfully beautiful and luxuriant on the

* The numerical distribution of these families will be found given in detail for the six great divisions of the globe in the ninth vol. of the Ann. of Nat. Hist. pp. 415, 416.

western coast, and British travellers speak of it in raptures; but whilst the climate continues so highly prejudicial to Europeans, we can only hope to draw feebly from its stores. Of thirty-five travellers on this coast of Africa, twenty-two have fallen victims to the malignity of the climate, four have been murdered by the natives, and nine have returned. The Asiatic cholera, which so startled the world at its first appearance, carried off an insignificant proportion compared with this*.

Thus then I feel at liberty to conclude, that a third of the vegetable kingdom has yet to find its way into the collections of botanists; and recapitulating our deductions in a tabular form, they will stand as follows:—

Number of species described in the first four volumes of DeCandolle's Prodromus	20,100
Allow for species since described or known to other botanists	5,000
Allow for Vasculares yet to be described in the above work	50,200
	75,300
Cryptogamous plants	13,870
	89,170
Undiscovered species	44,585
Total . . .	133,755

It is highly important that the amount of the vegetable world should be ascertained, as it becomes the basis on which numerous

* In the 'Historical and Descriptive Account of British India,' published in the 'Edinburgh Cabinet Library,' vol. iii. p. 162, is the following paragraph from the pen of Dr. Greville:—"It is extremely difficult to form an estimate of the probable extent of the Indian flora, the vegetation of many parts of the country being entirely unknown, and almost everywhere very imperfectly explored. In fact, in the remote districts, little more has been done than to follow the courses of rivers. The herbarium in the Museum of the East India Company contains about 9000 species, including those known and described by Roxburgh in his manuscript catalogue, most of which were at that time new. To this amount remain to be added a considerable number of new species in the collection of Dr. Wight. * * * Dr. Wallich obtained, from his own personal exertion, in the valley of Nepaul, and within an area of about sixty miles in circumference, upwards of 2500 species. Twelve months was the space of time devoted to this labour, and it cannot be supposed that he succeeded in discovering all the vegetable productions of that district. From these and other data it has been calculated by Dr. Wallich that we are not acquainted, at the present moment, with more than the eighth part of the flora of India; an estimate by no means improbable, but which gives to India itself as many species of plants as we find described in botanical works."

calculations are to be raised. In fixing it at 134,000 species, we have attempted to do for botany what Swainson has done for zoology; but in a comparison between the two, the number of plants is found to be considerably less than that of animated beings. The great amount of the latter is however chiefly composed of insects, the above author limiting them at 550,000, whilst he computes the rest of the animal kingdom at 27,600; the whole clothing the surface of the globe with 711,600 different and distinct forms of organized matter.

The following will give some idea of the distribution of vegetable forms in round numbers, in the six natural divisions of the world, and their relative amount to the extent of surface:—

		Square miles.
Europe	11,200	2,793,000
Asia	36,000	12,118,000
Africa	25,200	8,500,000
North America	14,400	11,146,000
South America	40,000	
Australasia	7,200	3,100,000
	134,000	37,657,000

As might be expected, by every one the least acquainted with the physical conditions of these sections of the world, there is no connexion between the extent of surface and the proportion of vegetation it supports. From the gross result it appears that for every species there is a superficies of 281 square miles of dry land; a space amply sufficient for the repetition of species in the form of individuals, the very numerous multiplications of which clothe the land with vegetation, and is a character which must not be undervalued, as plants vary much in the number of individuals which are comprehended under different species, and whose abundance constitutes the value of the latter.

Linnæus was the first naturalist who ventured an opinion as to the manner in which the earth was originally covered with species; he imagined them to have spread from a common centre. There is no ground for supposing otherwise than that all the kingdoms of nature had a similar origin and distribution, and that the laws obeyed by one were common to all; the views of Linnæus extended to all of them equally. Several theories have been since proposed, but they all may be regarded as one great theory, gradually formed as information accumulated, and step by step enlarging to suit the new facts continually brought to light. The earth being furnished with vegetation at the period mentioned in the sacred writings, no event occurred likely to have a material influence on it, and the botanist, being once acquainted as to the manner of the first distribution, has every reason to re-

main satisfied with his knowledge. With the zoologist it is different; the catastrophe of the deluge necessarily swept all animated beings from the surface of the earth, excepting those preserved in the ark; an opinion strengthened by geologists, who regard the deluge as having been universal. At the subsiding of the waters the animals emerged from a focus, whence they were to spread to all regions. As it is allowed that plants and animals were distributed by the same laws, and the universality of the deluge being also allowed, there is wanting something in the history of animals and plants to place them under the same conditions. As we shall presently see, plants did not spread from one or several centres, but simultaneously covered everywhere the dry land. The inferences urging this conclusion are numerous and satisfactory, and this point once established to the conviction of botanists, the animal kingdom must be left to the inquiries of the zoologist.

It was imagined by Linnæus that all plants, birds and beasts diverged from one centre; indeed, that all organized beings were created in one spot, whence they spread far and wide to beautify and people the earth. This region enjoyed a mild and lovely climate, and to secure those varieties of temperature necessary for the existence of many, it was provided with a range of mountains and intervening valleys, where each could enjoy that climate most congenial to its habits. It would be useless to attempt to refute this, as its inaccuracies are evident on the slightest inspection; even the facts adduced for its support cannot be admitted at the present day. It is evidently the offspring of the imagination of the author, which always adorned his conceptions and writings, but in this, as in other instances, was destitute of the necessary solidity. Perhaps no similar class of men were ever so devoted to science as the pupils of Linnæus; many of them were travellers, and by their researches in distant countries the study of plants became greatly extended. As facts poured in, the hypothesis of Linnæus gradually lost ground, for it was discovered that the state of botany in different countries did not bear it out. Instead of one centre it was now maintained that there had been several, whence all organized beings were disseminated, more particularly plants. Willdenow was the most conspicuous promoter of this view, but it was merely a transition to the opinions received at present. It was however still maintained that those centres were mountain-chains, now regarded rather as barriers to a flora than fit surfaces for its diffusion.

The present state of our knowledge invites us to the conclusion, that wherever there existed a suitable combination of circumstances, there vegetation sprung up. Whatever might have been the state of the surface, whether valley, mountain or plain, it made

no difference; if no unfriendly agents were at hand the soil was covered with plants. It seems highly probable that plants like animals are furnished with constitutions, having a nice perception of external circumstances, and though the inquiry assumes a microscopic tendency, we do not despair of discovering some very interesting facts, when a minute inquiry shall be instituted on the state of the different regions of alpine vegetation and the influences under which they flourish. On the other hand, if plants were diffused from one or more mountain-chains, the inquiry would end totally unproductive. Those circumstances which tend to establish the present view may be advantageously considered in detail.

1. The authority of the sacred writings.—The language of the Bible is brief, but there is no reason for limiting its meaning; the earth is stated, and why should not the whole earth be received? as bringing forth herbs and trees. That omnipotence which could call life into existence and cluster it around one centre was equally capable of spreading it over the whole earth.

2. The physical impediments presented by the distribution of land and water to the diffusion of species.—Since man has been an inhabitant of the globe, the changes in the relation of the seas and continents have been trifling, no event having occurred to disturb it; as they were at the creation they may be looked on as being now. That this disposition is such as powerfully to limit vegetation we shall presently see. Linnæus rested his hypothesis chiefly on the facilities, as he supposed, with which plants can be dispersed. He called to mind the great number of seeds and seed-vessels furnished with appendages presenting surfaces to the winds, and it must be acknowledged that the number of plants which nature has provided with organs for the diffusion of their seeds is very considerable. Nor can it be denied for an instant that *Erigeron canadense* was spread over Europe in every probability by the winds, assisted by the favourable structure of its seed-vessel; and next it may stand the fact, that *Canna indica*, though unprovided with any suitable organization, has been found a native alike of Asia, Africa and America. These however are but casualties, instances of departure from a general law, the exceptions which give birth to a rule; they are not the models representing the diffusion of species generally. There is every reason to suppose that the surface over which these plants are spread is confined, in spite of their highly favourable organization. It has often appeared to me, that birds, though furnished with such admirable organs for rapid locomotion, are very local in their habits. Every sportsman is acquainted with this circumstance, and is influenced by it in his search for game. If birds then with great locomotive powers are confined within restricted limits,

what may not be expected from plants, even though assisted by a favourable structure? Among these plants instances may be found which enjoy a very contracted habitat; *Carduus cyanoides* is one of these, and is found on two spots only in Germany. This plant has attached to its seed-vessel a brush of bristly hairs, like many other of its congeners, the use generally assigned to which is to assist diffusion, and which it often admirably accomplishes, though not in the present instance.

Numerous instances are related of seeds being carried by currents on the swell of the ocean across extensive seas from tropical coasts to the shores of northern countries. Fruits have often been picked up on the coasts of Scotland, Denmark and Sweden, which there is not the least doubt were shed within the tropics. Nor does the sea-water in all cases destroy the power of germination, as plants have occasionally been reared from them in our own country, and on the sandy beaches within the tropics the seeds of *Mucuna pruriens* are sometimes found in quantities in active germination, yet washed about by every rising tide. A more powerful agent has been man, who in his migrations has spread a number of plants in every place where he has fixed his residence; the proportion of these to the flora is however small, and they have seldom given a character to the vegetation*. It is therefore only in a few cases that it can be admitted plants have been thus diffused; the mass of vegetation has not moved over the world by this or similar methods.

A slight inspection of the tracery on a globe exhibits a certain relation in the distribution of water and dry land: towards the north a mass of land occupies the Arctic circle extending around the pole; traversing the globe on all sides towards the equator, divisions in the surface are gradually observed, increasing in size as they descend, and when arrived within the tropics, mostly enlarged into seas and oceans. The intervals between the masses of land beyond the equator more resembling processes shooting into the ocean, still increase, and towards the south are lost in a vast encircling sea. The tropical portions of each of the great divisions of the world are nearly isolated, whilst in the northern regions the consolidation is considerable, and the whole admits of a comparison, perhaps rather a rough one, of the manner in which the spread fingers are united at their base to the palm of the hand. In each of the divisions the vegetation of the tropics is rich and varied, but the identity in the productions of one with

* At Valparaiso in Chili, among a vegetation where they were in every respect strangers, I found the following plants:—*Linum catharticum*; *Sonchus oleraceus*; *Polygonum persicaria*; *Geranium molle*, *G. dissectum*; *Rumex pulcher*; *Mentha pulegium*; *Viola odorata*; *Equisetum palustre*. Similar instances are frequently mentioned in the writings of travellers.

the other is extremely slight; nor does this increase as we advance to the south. To the north, on the contrary, there is a gradual increase in the number of species occurring in the different divisions, and where the union of the land is great, many of the species have wide ranges of growth. It is stated that of the native flora of the United States, upwards of a seventh of the phanerogamic plants are common to Europe, and still further to the north the proportion is much greater. In the visits of Captain Beechey to Kotzebue's Sound in the Blossom ship of war, 233 species were collected; of these 117, or as nearly one-half as is possible, are met with in the north of Europe. Hence it appears that the large seas have been barriers to the diffusion of the present flora of the earth.

3. In confirmation of the views just expressed, we will mention some of the statements made by botanists respecting the frequency with which species are repeated, or in other words, the value of duplicates in those portions of the earth which have been subject to their investigations.

It is not unusual to meet with passages like the following in the narratives of even the most distinguished navigators. The author, the unfortunate La Perouse, is speaking of the vegetation around Port de Français, in 58° 37′ N.L.: "Among these potherbs we saw almost all that are common in the meadows and mountains of France;" and again in the same page, "No vegetable production of this country is unknown in Europe." The latter part of this is so far from being the case, that on this coast, and very near Port de Français, new species may still be discovered. It is most true that the general character of the vegetation is strikingly like that of France, England, or the North of Europe, and the traveller recognizes with much pleasure very similar plants to what he has been accustomed to see in his own country. But on a minute inspection, characters are discovered which distinguish many of them from their European representatives; whence we learn the importance of accurate and skilful observation in ascertaining what plants are to be considered as distinct from, or identical with, those of another country. In many instances this task is so difficult as to require all the judgement and experience of a practised botanist. It is only in the writings of the most sagacious travellers that we can hope to find that correctness in details worthy of implicit confidence.

The world may be divided into six sections, constituting so many distinct provinces of the vegetable kingdom, and having the watery barrier which separates them more or less complete. Europe is the first of these, and the isolation is less than in any of the others; Asia with its islands; Africa, including Madagascar and some islands; North America, extending as far south as

the isthmus of Panamà; South America, with which are included the West India islands and the barren Falklands; Australasia, composed of New Holland, New Zealand, and the Polynesian islands. Each division possesses certain characters peculiar to itself which distinguish it from the others, and may be conveniently regarded as a source of comparison.

No travels of modern date are better known than those of Humboldt and Bonpland in Equinoctial America, and none have been attended with such copious and accurate observations; though they frequently encountered, especially on elevated stations in the Andes, species of genera common in Europe, yet throughout their whole travels they never saw one exogenous plant which was found equally in the old and new world. Twenty-four species alone were discovered which occurred in the latter, and all these were *Gramineæ* or *Cyperaceæ*. Among 4160 species met with in New Holland by Dr. Brown, 166 were to be found in Europe; 15 of these are *Exogenæ*; 121 belong to *Cryptogamia*, being nearly two-thirds of the number; and 30 to *Gramineæ* or *Cyperaceæ*. On a portion of the north-west coast examined by Mr. Cunningham he collected 1500 plants, and only 52 of these were repeated either in India or South America. Adanson in his 'Voyage to the Senegal' mentions, that he only saw two plants in the neighbourhood of that river which he had seen in Europe, tamarisk and purslain. At another river on the same coast, the Congo, of 600 species collected, Dr. Brown has stated that about a twelfth only were met with in South America and India. In high latitudes alone do we find that extensive diffusion which refuses to every restricted spot its own flora. A list of 409 species belonging to Greenland contains only nine peculiar to that country.

So far then we find little reason to conclude that vegetation originated in one or a few centres, since there is so little identity among plants of different countries.

4. Had the migration proceeded from a few localities, we should have expected to find, in all situations with similar climates, the identically same species of plants.—That such is not the case is evident from the preceding, but a few moments will be well occupied in showing what does happen here. It is a fundamental principle in geographic botany, that everywhere under similar circumstances similar, but not identical, species exist; this is a well-known fact, which the daily acquisitions to our knowledge continue to confirm. There is a marked resemblance in their productions, though the localities under comparison may be widely separated; the productions of the Asiatic tropic strongly resemble those of the American; the temperate extremity of Africa has many points of similarity with the tem-

perate portion of New Holland; and the southern extremity of America possesses many circumstances to remind the botanist of the North of Europe or America.

Occasionally these characters are conveyed by the presence of natural families, and their value increases inversely to the number of species they contain. A small family, composed but of a few species, has less means of being represented in different localities than a more bulky one. The closest connexions are furnished by genera, these being founded on a more minute view of their organization, and on characters shared by a smaller number of vegetable forms. A variety of remarkable instances are contained in botanical works* exhibiting lists of plants in one tropic or temperate region having kindred species in others, differing in a slight degree only, yet possessing those distinctive marks with a tenacity which makes it extremely difficult to arrive at any other conclusion than that they are separate species. Some of the natural families are very generally diffused; as the most remarkable may be mentioned—*Leguminosæ, Malvaceæ, Ranunculaceæ, Caryophylleæ, Cruciferæ, Umbelliferæ,* &c. The genera of some of these are also extremely ubiquitous; *Trollius* has been often cited as a remarkable instance, and as it is a genus of few species, the case is more striking. No genus of equal extent surpasses *Senebiera* in the wide diffusion of its species; it comprises eight species, two of which are European, whilst the Cape of Good Hope, St. Helena, Madagascar, Monte Video, Quito and Egypt, has each its peculiar kind.

5. Those islands which are so far removed from the nearest mainland, that their vegetation may be considered to be independent of it, have much that is peculiar in their flora.—Though there is not the least objection to consider many of them as the summits of submarine chains of mountains, it is not probable that they should have been so many centres of vegetation. If the latter were so numerous as to embrace even these, the theory must be regarded the same as that which maintains an universal creation. Some islands are but specks on the globe, and yet we find them with numerous peculiar species. The vegetation of St. Helena is almost altogether its own, having very few plants common with Africa or America. Among 239 plants collected at the Sandwich islands, exactly 100 have not hitherto been found elsewhere, not even in the other Polynesian islands. The Society islands have also a number of their own. Notwithstanding the immediate vicinity of the Canary islands to the coast of Africa, there were found to be thirty peculiar of sixty-four collected. It is only on islands situated as Malta, and originally extremely

* Willdenow, Introduction to Botany; Sprengel, Philosophy of Plants.

barren, that the flora is altogether that of the adjacent continents; or in some of the coral groups in the Pacific, such as the Radack chain, perhaps within no distant period first emerged from the ocean, which have received their plants from neighbouring islands.

6. The absence of any circumstances tending to support a change in the condition of the vegetable kingdom, such as the production of new species, or the disappearance of others.—Lyell has used considerable ingenuity in his attempt to prove, "that the species existing at any particular period must, in the course of ages, become extinct." A conclusion of this kind was highly desirable to establish his views, but we cannot help placing a different estimate on the speculations of Brocchi. It is quite gratuitous to suppose, that species like individuals might advance in age, from "certain peculiarities of constitution conferred on them at their birth." I may venture confidently to affirm, that as far as experience yet goes, we have no reason to conclude that plants have disappeared; nor can we allow that new species have appeared, hybrids seldom occurring in nature, and when produced by art only continuing through two or three generations.

These facts vary in the value to be attached to them severally, but collectively they form a powerful argument in support of the theory, that the earth was everywhere, at the same moment, furnished with a vegetation in accordance with the physical circumstances which prevailed. The exact state in which vegetation first existed, whether springing up from seeds, or in flowers and fruit, whether originally assuming the weakest phase in the circle of its existence, or appearing at once in the full vigour of its growth, this is needless for us to inquire. It is most probable, that as the wants of man were suddenly created, the means of gratifying them were co-existent; such is the conclusion to be drawn from the sacred writings; and if ever we were gratified by a knowledge of this minute particular, it would be of no service to us, being a solitary circumstance and without any connexion with the subsequent state of the original flora of the world.

Many of the natural families are so widely diffused, that they are represented in nearly every portion of the globe. More than a third of the whole have members in the six divisions already stated, a greater number still in five of these, and so on, till we find but a few left which occupy or are confined to a solitary division. Among the ten agamic families there is only one, *Marsileaceæ*, not found in them all. Those which are confined to one province are,—in Europe, *Globularineæ, Ceratophylleæ*; in Asia, *Dipterocarpeæ, Aquilarineæ, Camellieæ, Hydrocereæ, Moringeæ, Stilagineæ*; in Africa, *Bruniaceæ, Brexaceæ, Belvisiaceæ, Penæaceæ*; in North America, *Fourquieraceæ, Sarracenieæ*; in South

America, *Rhizoboleæ, Monomieæ, Simaroubiaceæ, Vochyaceæ, Calycereæ, Escallonieæ, Humiriaceæ, Lacistemeæ, Papayaceæ, Gilliesieæ, Gesnereæ;* in Australasia, *Tremandreæ, Baueraceæ, Epacrideæ, Goodenoviæ, Stackhouseæ, Bruniaceæ;* being thirty-one in number, or an eighth part of the whole.

In addition to the geographical divisions here followed, there is another which may be regarded as accessory to it. In the present instance the distribution of heat has been the leading consideration, which is well known, as a general rule, to diminish from the equator to the poles. The first region extends from the equator to the limits of the tropic in the northern hemisphere, or 23° 28′ N.L. The second is comprehended in the space between this and the parallel of 40° N.L., and is called the sub-tropic; the next extends from 40° to 60° N.L., being the temperate; and the last or arctic comprises all the surface north of 60°. As the regions are repeated in the southern hemisphere, the whole are necessarily eight in number; the north tropic, south tropic, north sub-tropic, south sub-tropic, north temperate, south temperate, arctic and antarctic. The last is scarcely more than a nominal region, though it still claims a few terrestrial plants and some Algæ, which make its existence necessary.

Inquiries have sometimes been made as to what are the most prominent sources of difference in the character of the vegetation, or of the composition of the respective floras, of the two hemispheres. To afford some illustration of this, those families are here enumerated which are more particularly distinguished for having the mass of their numbers in one or the other. Those families already mentioned as confined to one division have been omitted, as the repetition would only occupy useful space. The south tropic families are usually to be found in the Brazils, whilst the south sub-tropic, as *Oxalideæ, Diosmeæ, Proteaceæ, Polygaleæ,* are chiefly from the Cape of Good Hope, New Holland and South America. The list might be very easily enlarged, but our object is only to furnish the most striking.

In the northern hemisphere are predominant, *Acerineæ, Aurantiaceæ, Artocarpeæ, Amentaceæ, Berberideæ, Borragineæ, Caryophylleæ, Cistineæ, Cruciferæ, Coniferæ, Cupuliferæ, Campanulaceæ, Caprifoliaceæ, Dipsaceæ, Elæagneæ, Fumariaceæ, Grossulaceæ, Hypericineæ, Hippocastaneæ, Hamamelideæ, Magnoliaceæ, Onagrariæ, Orobancheæ, Papaveraceæ, Rosaceæ, Ranunculaceæ, Rutaceæ, Resedaceæ, Saxifrageæ, Umbelliferæ, Vaccineæ, Alismaceæ.*

In the southern hemisphere are predominant, *Atherospermeæ, Cacteæ, Crassulaceæ, Capparideæ, Diosmeæ, Dilleniaceæ, Ficoideæ, Geraniaceæ, Heliotropiaceæ, Myrtaceæ, Melastomaceæ, Myoporineæ, Malpighiaceæ, Oxalideæ, Pittosporeæ, Polygaleæ, Proteaceæ, Sca-*

voleæ, Spigeliaceæ, Stylideæ, Tropæoleæ, Amaryllideæ, Hæmodoraceæ, Irideæ, Restiaceæ.

As has been stated, a considerable number of the natural families are represented in all the six divisions, and, *cæteris paribus,* those with the largest amount of species may be justly supposed to be in this respect the most prominent. With increased numbers not only are the means of repetition multiplied, but there is greater scope for variety of habit and predilection; the former displayed in the diversity of herbs, shrubs and trees, and the latter in peculiarity of constitution. Those most distinguished for a large amount* of species, as *Cruciferæ* with 990, *Myrtaceæ* 715, *Leguminosæ* 3875, *Umbelliferæ* 1009, *Cinchonaceæ* 1631, *Caryophylleæ* 759, have the most extensive range. It does not appear that the habitat is influenced by the number of genera, as might at first be supposed, since there are comparatively few in *Malvaceæ, Caryophylleæ, Leguminosæ* and *Geraniaceæ;* about the average number in *Cruciferæ,* but below it in *Cinchonaceæ.* Of the hundred natural groups previously referred to, thirty-three are distributed through all the divisions, whilst

Europe has representatives of . .	52
Asia	83
Africa	76
North America	81
South America	83
Australasia	53
Confined to a single division . .	9

The number of genera composing the families varies considerably; those of tropic or sub-tropic regions appear to have more than others of temperate regions in proportion to the species; but the tropic families do not abound generally either in genera or species. *Leguminosæ* with 272 genera, *Cinchonaceæ* 215, *Cruciferæ* 100, *Umbelliferæ* 160, are among the largest. Some consist only of one or two genera and scarcely more species; others with a large amount of species have but few genera, as *Geraniaceæ* with 490 species and only five genera; *Loranthaceæ* 330 species and four genera; *Oxalideæ* 159 species and also four genera. As instances to the contrary are *Aurantiaceæ* with forty-four species and twelve genera; *Olacineæ* seventeen species and eight genera; *Droseraceæ* forty-five species and eight genera; with *Bombaceæ, Meliaceæ, Magnoliaceæ, Flacourtianeæ.* Taken collectively, the whole amount of natural families possesses an average of upwards of eighteen genera each, or more correctly

* The numbers stated are obtained from DeCandolle's 'Prodromus Regni Vegetabilis.'

18·8. Proceeding in the same manner to estimate the number of species in each genus, they will be found to average upwards of ten to each, or 10·6. As the value of the group or assemblage depends on the amount of its component parts, so we must regard the value of a natural family or genus as governed by the number of its constituents; 18·8 is then the average value of a family, and 10·6 of a genus.

A discrepancy of opinion is not unlikely to arise respecting what should be considered as the division of the globe to which a natural family belongs. Each of the latter is formed by the aggregation of two classes of constituents, of different value and number, these being inversely to each other. The genera, as originating in characters of greater value, may on the one hand be considered to determine this, and on the other the great numerical proportion of species may be regarded as conclusive. Many of the families which possess the greatest proportion in one division are represented by a superior number of genera in some other, where the amount of species is smaller; to which then of the two does the group essentially belong? In reply we must confess that frequently it is extremely difficult to decide, and in some cases altogether impossible, since the characters approximate so closely in value. An analysis of *Byttneriaceæ* will more clearly explain this: if the number of species alone are regarded, the mass of the family is African, and afterwards South American; but if guided by the genera it is essentially Asiatic, whilst Australia follows with very few species.

Byttneriaceæ:—Genera 35, Species 221.						
	Europe.	Asia.	Africa.	N. America.	S. America.	Australia.
Genera	...	22	7	7	8	9
Species	...	50	88	10	60	15

Magnoliaceæ is another instance; and in this case we can hardly venture to say which of the two, Asia or North America, claims it most forcibly.

Magnoliaceæ:—Genera 9, Species 40.						
	Europe.	Asia.	Africa.	N. America.	S. America.	Australia.
Genera	...	3	...	4	4	2
Species	...	16	...	12	9	3

The native country of a family or genus is evidently an inappropriate expression; it assumes that some of its members have migrated from their original place of growth, a circumstance

altogether at variance with an opinion already expressed. The world alone is their native country, and North America is as much the native country of *Byttneriaceæ* with only ten species, as is Africa with eighty-eight. There is another term frequently adopted, and within certain limits it is a correct one. Where the greatest number of the species of a genus or family abound, there is its metropolis; but it expresses no more, and we are still at a loss for a word to convey what is meant by the assemblage of generic and specific characters as just mentioned. In this case our ideas are best conveyed by using the adjective term of the division wished to be expressed; thus if any family has the preponderance of its constituents of genera or species, or both, in Europe, it would be requisite to call that family European, as to this province it essentially belongs.

Though the amount of individuals composing genera presents a much smaller aggregate than is met with in the natural families, still it is surprising how widely their species are diffused, and how comparatively rare it is to find them bounded by narrow geographic limits. The greater portion of those genera, composed of any tolerable number of species, obey the law with eagerness, to reappear wherever there may be a combination of circumstances propitious to their growth. To illustrate this, let us take that important natural group *Ranunculaceæ*, and examine how far its genera are circumscribed. Commencing with its type, *Ranunculus*, we shall find that it has members in all of the six divisions. The same will nearly apply to *Clematis* and *Anemone*. Very few genera are confined to a single province, perhaps *Knowltonia* may be cited as the only one, where the number of species is sufficient to admit of a deviation; this genus has five species, all inhabitants of the Cape of Good Hope. In *Cruciferæ*, *Capparideæ*, *Umbelliferæ*, *Malvaceæ* and *Caryophylleæ* the genera have a similar diffusion. *Cruciferæ* is remarkable for containing one extensive genus, *Heliophila*, of forty-seven species, all from Southern Africa.

As genera then collectively manifest so slight a disposition to range within narrow limits, it will be more satisfactory to examine those instances in which they exist under opposite circumstances, or are comparatively circumscribed. The genera of *Myrtaceæ* are remarkable for this, and omitting those which contain but one or two species, there are about twenty which are limited to one of the divisions. Australia, always peculiar in its natural productions, claims the greater share, comprising all important from the number of their species, and the beauty or singular structure of their flowers. The most prominent of these are *Eucalyptus*, *Calothamnus*, *Melaleuca*, *Metrosideros*, *Leptospermum*, *Calythrix* and *Callistemon*. A few solitary cases occur

among these of species co-existing in other divisions, but are too rare to be of importance. In the same family, and confined to the South American province, are *Myrcia* with numerous species, *Calyptranthes, Lecythis,* and nearly the whole of the extensive genus *Eugenia.* Asia is less remarkable, having only a few genera scanty of species, as *Barringtonia, Stravadium, Sonneratia,* &c. *Portulaceæ,* by no means a large family, having only fourteen genera and ninety species, presents *Anacampseros* with ten species, *Ginginsia* seven, natives only of the Cape of Good Hope; *Calendrinea* fourteen, of South America; *Claytonia* twelve, of North America and Siberia; *Aylmeria* two, of New Holland. If Asia possess few of the restricted genera of *Myrtaceæ,* the deficiency is amply supplied by a large share of *Cinchonaceæ,* the amount of whose species, found in the hotter parts and in the Malaisian islands, is very great. Still it must yield to South America. The restricted genera are chiefly *Wendlandia* with sixteen species, *Mephitidea* eighteen, *Chasalia* nine, *Danais* four, to Asia; *Cinchona,* as limited to sixteen species, *Coccocypselum* sixteen, to South America; *Anthospermum* with nine species to the Cape of Good Hope; and *Opercularia* with thirteen species to New Holland, including two species belonging to New Zealand. *Leguminosæ* contains a great number of genera, but none of the larger have a limited habitat, excepting alone *Aspalathus,* which with eighty-four species is confined to the Cape, omitting a doubtful species. There are however a number of smaller genera, belonging chiefly to the suborders *Sophoreæ* and *Loteæ,* the greater portion of which are natives of the Cape of Good Hope and New Holland, and comparatively a few from India and South America.

Occasionally it happens that the sections into which many of the genera are divided possess but a limited range. This occurs with *Acacia,* which comprehends 258 species; one of its sections, consisting of sixty-four species, has that peculiar structure of the leaf which is called phyllodium; nearly the whole of these grow spontaneously in New Holland and the Polynesian islands, a few only being met with in Africa or Asia. The other sections with pinnate leaves are distributed through South America, Africa, Asia and Australia, especially the former. They have also a little variety in the colours of their flowers, being yellow, white, and sometimes pink; but the Australian species have all yellow flowers. *Vitis* has two sections dependent on the union or separation of the sexes in the same plant; the hermaphrodite species are natives of the warmer regions of Asia, whilst the dicœcious occur in North America. In *Ceanothus* the manner of inflorescence, to some extent, co-exists with a limited geographic range of the sections.

When a group of plants is discoverable only in one of the great divisions or regions, it will be convenient to apply to it the term monomic, as expressive of its geographic properties; thus *Vochyaceæ*, being confined to South America, is a monomic family; and *Cliffortia*, whose shrubby species are all indigenous to South Africa, is a monomic genus. On the other hand, a natural family common to all the divisions, and these are about a third of the whole, are called polynomic; and a genus with a similar range, as *Viola* or *Ranunculus*, is a polynomic genus. If a group is restricted to two or more of the divisions, the appropriate Greek numeral must be substituted; thus *Acerineæ*, the members of which are natives of the temperate and sub-tropic regions of Europe, Asia and North America, is a trinomic family.

The value of the generic character is 10·6; an amount the result of an extensive estimate, though not of the whole vegetable kingdom, which unfortunately is not within our reach at present in a satisfactory form. This may however be considered as very closely approaching correctness, and giving us a tolerable accurate notion of the importance of the genus; compared with some of the statistical details which have become current of late years, it must be allowed to stand on a much firmer and broader foundation, and therefore not less worthy of faith. If all the species then were equally distributed among the genera, the share that would fall to each would be about ten and a half; but the genera are not so regularly composed, and when studying a very bulky or a small genus, the average shows us how far the group under consideration departs from the standard. The smaller genera greatly prevail, whilst some of the largest possess a great multitude of species. Those which contain but a single species bear a great proportion to the others, which I am disposed to think will diminish when the affinities of the genera to each other are better understood.

In Byttneriaceæ with	. .	35	genera,	11	have only one species.	
Caryophylleæ	„ . .	27	„	7	„	„
Cruciferæ	„ . .	100	„	34	„	„
Leguminosæ	„ . .	272	„	80	„	„
Myrtaceæ	„ . .	47	„	11	„	„
Sapindaceæ	„ . .	29	„	12	„	„
Terebinthaceæ, D.C.	.	55	„	24	„	„
Umbelliferæ	. .	160	„	64	„	„

At the same time that some of these trifling genera become merged into others, it is highly probable that the more extensive will undergo analysis, leaving the average proportions very slightly affected. A few of the largest genera at present are, *Pelargonium* with 369 species, *Mesembryanthemum* 316, *Acacia* 258, *Loranthus* 251, *Astragalus* 244, *Silene* 217, *Cassia* 211.

It is not possible to assign a value to species with that precision which can be adopted with families and genera; any attempt to bestow on them a numerical amount must utterly fail, making it requisite to adopt some other method. Some idea of their importance may be obtained by taking a comparative view of the relations they occupy towards each other, and to the whole mass of vegetation. It would appear that every species of plant has, on an average, somewhere about 281 square miles of surface to increase and multiply on; and making every allowance for those tracts of country which local causes render unfit to support a vegetation, we become highly sensible how infinitely multiplied the species must be to clothe the earth with that abundance we behold around us. The different species will vary in their power of multiplying individuals, either from their organization or surrounding causes; and there would also appear in some cases an idiosyncrasy which refuses to perfect their increase or diffusion. 1. The value of species is smallest in plants existing in only one or two solitary localities; such for instance as the cedars of Lebanon, which are indigenous alone in a circumscribed spot, and are so few in number that they can be counted. Many others are extremely local, especially of the *Orchidaceæ* of South Africa and New Holland, which are often only to be met with in the most solitary and secluded spots. The localities of some species of *Disa* and *Serapias* at the Cape have become well known from this very circumstance. Thunberg mentions that *Codon Royeni* and *Protea nana* are both rarities at the Cape; *Origanum Tournefortii* is alone found on the island of Amergos; *Forstera sedifolia* is a rare plant in New Zealand. These are instances where not only the geographic range is small, but also the amount of individuals. 2. The value is increased in those which have a wide geographic range. Here is included the mass of vegetation, and it comprehends all plants excepting those under the next head. Some have a greater distribution than others; it is a general rule, that the more simple the organization the greater is the diffusion; hence the frequency with which agamic species are repeated. Aquatic plants have also a wide range; *Lemna minor* is abundant throughout the northern hemisphere; *Typha latifolia* is equally diffused; also the species of *Nymphæa* generally, and *N. lotus* beautifies alike the waters of the Nile and the Ganges. *Arundo phragmites,* abundant throughout Europe, reappears in the marshes of the Macquarrie in New South Wales. 3. The value is at its maximum in those species, the individuals of which are exceedingly numerous, and are so crowded together, to the exclusion of all others, that they appear to require the society of each other, and from this latter circumstance have been called *social plants.* The *Gramineæ* are generally social, and in

our meadows another eminently social plant, *Polygonum persicaria*, often struggles among them. *Erica vulgaris* covers large tracts in the temperate regions of Europe; *Ericaceæ* generally consists of social plants. *Filices, Musci, Leguminosæ, Compositæ*, and many other natural groups, contain numerous instances. Within the tropics some species of *Cactus, Aloe, Bromelia* and *Agave* become great nuisances from their social habits. Many display this character simply because there is no check to their mode of growth; this happens with the greater part of aquatic plants, as *Pontederia, Nymphæa, Nelumbium, Hydrocharis, Sagittaria*. Indeed plants are social from causes which are often so trifling, that it is a character of little value, excepting occasionally in Geographic Botany.

Yet after all, this presents but a feeble sketch of the vegetable clothing of the globe.

[To be continued.]

III.—*On the Occurrence of the Genus* Pollicipes *in the Oxford Clay.* By John Morris, Esq.

[With a Plate.]

The fossil species of the family Cirrhipeda, hitherto recorded as British, all belong either to the tertiary or cretaceous series; the pleistocene, marine and crag formations contain remains of species belonging to the genera *Acasta, Adna, Balanus, Clitia, Coronula* and *Scalpellum*. The upper marine, the London clay, and the different members of the cretaceous system contain only species of the genus *Pollicipes*, so that the addition of two new species of the latter genus from the Oxford clay is an interesting fact connected with its geological distribution.

Pollicipes concinnus. (Pl. VI. fig. 1.)

Testa subtrigona; valvulis lateralibus, anticis trigonis apice acuminato, posticis subtrapeziformibus; dorsali angustiori acuminata. Pedunculo squamulifero, squamulis adpressis subquadratis, transversim carinatis.

The compressed state of the specimen prevents the specific characters from being more accurately defined. The anterior valves are trigonal, the posterior somewhat trapeziform; the dorsal valve appears to have been narrow and acuminate. The peduncle is tolerably well preserved and consists of a series of small closely pressed scales, somewhat quadrate in form, each of them being regularly marked by a transverse carinated ridge, presenting a very neat and uniform appearance.

The figure (Pl. VI. f. 1.) represents an interesting group of this species, consisting of three principal individuals, surrounded